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RESPONSE OF BORON AND SULPHUR ON GROWTH AND YIELD OF INDIAN MUSTARD (*BRASSICA JUNCEA* L.) UNDER IRRIGATED CONDITION OF U.P.

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ABSTRACT

A field experiment was conducted during the *Rabi* season of 2021-22 at the Research Farm, Faculty of Agricultural Sciences & Allied Industries, Rama University, Kanpur Nagar to study the effect of Indian mustard to different levels of sulphur and boron. The experiment was comprised of 9 treatments with including all the combination of three levels of sulphur (0, 10 and 20 kg ha^{-1}) and boron (0, 2 and 4 kg ha^{-1}). Results revealed that the highest plant height (cm), dry matter accumulation (g plant^{-1}), crop growth rate (g m^{-2} day^{-1}), relative growth rate (g g^{-1}day^{-1}), Number of siliqua plant^{-1}, Number of seeds siliquae^{-1}, test weight (g), Seed yield (q ha^{-1}), Stover yield (q ha^{-1}) were recorded with application of Sulphur @ 20 kg ha^{-1} and boron 2 kg ha^{-1}.

***Keywords*: Boron, Mustard, Sulphur, Yield**

INTRODUCTION

Mustard is the second most important oil seed crop, contributing nearly 25-30% of the total oil seed production in the country. Optimum nutrition is required for getting maximum seed yield and good quality of the grain. Several abiotic and biotic factors have been found to effect mustard yields apart from major plant nutrients (N, P and K) sulphur and boron play an important role in the production phenology of oil seed crops and these crops respond well to applied sulphur and boron (Karthikeyan and Shukla, 2008). For oil seeds, sulphur and boron are most vital nutrients for the growth and development. Sulphur is considered to be the fourth important essential nutrient after nitrogen, phosphorus and potassium for the plant growth. Sulphur performs many physiological functions like synthesis of cystein, cystine, methionine chlorophyll and oil content of oil seed crops. It is also responsible for synthesis of

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certain vitamins (B, biotin and thiamine), metabolism of carbohydrates, proteins and oil formation of flavour compounds in crucifers. Brassica has the highest sulphur requirement owing to the presence of sulphur rich glucosinolates. Boron is an essential micronutrient for higher plants. The role of B within the plant includes cell-wall synthesis, sugar transport, cell-division and different actions in membrane functioning, root elongation, regulation of plant hormone levels and generative growth of plants. The quality of seeds deteriorated in decreased content of boron, starch, protein and oil along with stimulated concentrations of sugars and phenols. Application of B is essential for crops grown in soils with available B belong critical limit of 0.5 mg kg^{-1} (Ramana *et al*. 2016). However; studies investigating the impact of sulphur and boron application on yield of mustard remain scarce. Therefore, the present investigation was planned to study the effect of sulphur and boron on yield, nutrient uptake and quality of mustard.

MATERIALS AND METHODS

A field experiment was conducted during the *Rabi* season of 2021-22 at the Research Farm, Faculty of Agricultural Sciences & Allied Industries, Rama University, Kanpur Nagar. The soil was sandy loam, slightly above neutral in reaction (pH 7.3), low in organic carbon (0.3 %), available potassium (79 kg ha^{-1}) and low in available phosphorus (34.5 kg ha^{-1}). Treatments consisting of three levels of sulphur (0, 10 and 20 kg ha^{-1}) and boron (0, 2 and 4 kg ha^{-1}) were replicated thrice in randomized block design. For recording observations on growth and yield attributes viz., plant height (cm), plant dry weight (g/plant), crop growth rate (g/m2/day), relative growth rate (g/g/day), number of siliqua, number of seed per siliqua, test weight (gm), seed yield (t/ha), stover yield (t/ha) and harvest index (%).

RESULTS AND DISCUSSION

The observations for growth parameters are being presented in the table 1. A perusal of this table reveals that there was a steady increase in the plant height (cm), dry matter accumulation (g plant^{-1}), crop growth rate (g m^{-2} day^{-1}) and relative growth rate (g g^{-1} day^{-1}) showing some significant impact on the effect of sulphur and boron on growth of mustard. While as relative growth rate (g g^{-1} day^{-1}) the effects of the treatments were non-significant. There was significant difference between the treatments and maximum plant height

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(163.01cm) was observed the applications of sulphur @ 20 kg ha^{-1} + boron 2 kg ha^{-1} (T_8), whereas the lowest plant height (127.10 cm) was recorded under control plot (T_1). However, application of sulphur @ 10 kg ha^{-1} was found statistically at par to application of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}. There was significant difference between the treatments and maximum plant dry weight (67.85 g) was observed the applications of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}, whereas the lowest plant dry weight (44.70 g) was observed in control plot (T_1). There was significant difference between the treatments and maximum crop growth rate (9.63 g m^{-2} day^{-1}) and relative growth rate (0.0107 g g^{-1} day^{-1}) were recorded with the applications of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}, whereas the control plot (T_1) were recorded the lowest crop growth rate (4.69 g m^{-2} day^{-1}) and relative growth rate (0.0061 g g^{-1} day^{-1}). Result are in agreement with the findings of Verma *et al*. (2012). The increase in plant height because sulphur increased activity of merismetic tissue resulting in increase in plant height and cell elongation and boron also helps in cell elongation, photosynthesis and translocation of photosynthates. The availability of nutrient in adequate amount resulted in formation of photosynthates, which promote the metabolic activities, increased cell division, ultimately increase the number of primary and secondary branches. A similar finding was found by Yadav *et al.* (2016). In case of dry matter accumulation boron and sulphur helps in formation of deep green colour due to synthesis of chlorophyll which in turn provide the larger area for photosynthesis. This results in greater amount of dry matter accumulation in comparison to sulphur deficient plant (Kumar and Yadav, 2007).

Observations regarding the response of Boron and sulphur on yield and yield attributes of Mustard (*Brassica spp.*) are given in table 2. The observation showed that at yield and yield attributes there was significant difference between treatments. The results revealed that there was significant difference between the treatments and maximum number of siliqua $plant^{-1}$ (335.89) was observed by the application of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}, whereas the lowest value number of siliqua $plant^{-1}$ (257.14) was observed under control plot (T_1). Similar findings were also recorded by Kumar *et al*. (2000) and Akter *et al*. (2007). Yeasmin *et al*. (2013) had also reported positive effect of various levels of sulphur application on yield component of mustard. Optimum dose of boron significantly increased the number of seeds/siliqua. Nutrients requirement increases during initial stages to develop stages of grain filling in mustard. Thus application of boron and sulphur helps in

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photosynthesis and their translocation to sink. Kumar *et al.* (2000) and Jat *et al.* (2008) reported similar findings. The results revealed that there was significant difference between the treatments and maximum number of seeds per siliqua (14.20) was observed by the application of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}, whereas the lowest value number of seeds per siliqua (10.14) was observed in control plot (T_1). However, application of sulphur @ 20 kg ha^{-1} + boron @ 4 kg ha^{-1} are found statistically at par to sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}. The results revealed that there was significant difference between the treatments and maximum test weight (6.0 g) was observed by the application of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}, whereas the lowest value test weight (4.2 g) was recorded under control plot. The results revealed that there was significant difference between the treatments and maximum seed yield (26.16 q ha^{-1}) was observed by the application of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}, whereas the lowest value seed yield (19.52 q ha^{-1}) was recorded in control plot (T_1). However, application of boron @ 2 kg ha^{-1} are found statistically at par to sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}. The results revealed that there was significant difference between the treatments and maximum stover yield (68.45 q ha^{-1}) was observed by the application of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1}, whereas the lowest value stover yield (43.38 q ha^{-1}) was observed in control plot. The results revealed that there was significant difference between the treatments and maximum harvest index (68.45 %) was observed in control plot. The enhancement of seed yield in mustard due to the application of sulphur had also been reported by Suresh *et al.* (2002) and Raut *et al.* (2003). This improvement might be due to the translocation of photosynthates leading to improvement in higher seed yield and stover yield. Chatterjee *et al.* (1985) reported that application of borax increased seed yield of mustard over control. This may be due to the role of boron in fertility improvement and translocation of photosynthates to sink. These results are in close conformity to those of Chander *et al.* (2010).

Table 1 Different growth parameters of Indian mustard as influenced by boron and sulphur levels

Treatment	Growth parameters			
	Plant height (cm)	**Dry matter accumulation (g plant^{-1})**	**Crop growth rate (g m^{-2} day^{-1})**	**Relative growth rate (g g^{-1}day^{-1})**
T_1 control (S_0 B_0)	127.1	44.70	4.69	0.0061
T_2 Boron 2 kg ha^{-1}	160.1	61.19	5.21	0.0076
T_3 Boron 4 kg ha^{-1}	159.2	60.14	6.87	0.0084

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T_4 Sulphur 10 kg ha^{-1}	154.0	52.12	5.88	0.0083
T_5 Sulphur 10 kg ha^{-1} + Boron 2 kg ha^{-1}	160.7	61.80	7.38	0.0088
T_6 Sulphur 10 kg ha^{-1} + Boron 4 kg ha^{-1}	150.8	58.85	6.33	0.0078
T_7 Sulphur 20 kg ha^{-1}	147.1	54.30	5.20	0.0069
T_8 Sulphur 20 kg ha^{-1} + Boron 2 kg ha^{-1}	163.01	67.85	9.63	0.0107
T_9 Sulphur 20 kg ha^{-1} + Boron 4 kg ha^{-1}	161.6	63.31	8.01	0.0094
SEm (±)	4.0	1.73	0.867	0.002
C.D. (p=0.5)	8.5	3.679	1.838	N.S.

Table 2 Effect of Boron and sulphur on yield and yield attributes of mustard

Treatment	**yield attributes and Yield**					
	Number of siliqua plant^{-1}	Number of seeds siliqua^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
T_1 control (S_0 B_0)	257.1	10.1	4.24	19.52	43.38	31.07
T_2 Boron 2 kg ha^{-1}	323.4	11.3	5.02	24.09	62.27	27.89
T_3 Boron 4 kg ha^{-1}	322.7	11.8	5.38	23.78	62.38	27.59
T_4 Sulphur 10 kg ha^{-1}	323.1	11.2	5.41	21.94	51.77	29.77
T_5 Sulphur 10 kg ha^{-1} + Boron 2 kg ha^{-1}	316.7	11.8	5.25	22.49	64.31	25.92
T_6 Sulphur 10 kg ha^{-1} + Boron 4 kg ha^{-1}	319.2	12.4	5.30	22.92	62.50	26.83
T_7 Sulphur 20 kg ha^{-1}	319.9	12.1	5.24	23.78	61.72	27.82
T_8 Sulphur 20 kg ha^{-1} + Boron 2 kg ha^{-1}	335.9	14.2	6.03	26.16	68.45	27.66
T_9 Sulphur 20 kg ha^{-1} + Boron 4 kg ha^{-1}	334.4	13.2	5.79	25.43	64.45	28.29
SEm (±)	4.0	0.4	0.25	0.65	1.42	0.88
C.D. (p=0.5)	8.4	1.1	0.64	1.39	3.01	1.87

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CONCLUSION

It is concluded that application of sulphur @ 20 kg ha^{-1} + boron @ 2 kg ha^{-1} was found to be the best treatment for obtaining higher grain and straw yield as compared to rest of the treatments.

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